# Bonneville Power Administration
# FY 2003 Provincial Project Review

## PART 2. Narrative

### *Important notes*

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**Project ID:** (Replace this text with your response)

**Title:** Develop and Implement a Pilot Status and Trend Monitoring Program for Salmonids and their Habitat in the Wenatchee and Grande Ronde River Basins.

## Section 9 of 10. Project description

### a. Abstract

This proposal seeks to develop, as subbasin scale pilot programs, status and trend monitoring efforts for anadromous salmonids and their habitat in the upper Wenatchee and Grande Ronde River basins. This work builds on current status and trend monitoring programs being developed in the Oregon portion of the Columbia Plateau (BPA proposal #25088) by extending the pilot program development process to two additional subbasins. This proposed work differs from much of the ongoing status and trend monitoring in the Columbia River basin as it focuses on the explicit development and testing of the sampling protocols and methodologies required for generating habitat and population monitoring data of known spatio-temporal resolution, accuracy and precision.

The status and trend monitoring program for anadromous salmonids and habitat in the Wenatchee and Grande Ronde River basins will serve three major data collection efforts:

- --At the scale of a subbasin, assess on an annual basis the status of adult populations of anadromous salmonids.
- --At the scale of a subbasin, assess on an annual basis the population status or productivity of juvenile anadromous salmonids.
- --At the scale of a subbasin, assess on an annual basis the status of salmonid habitat.

Data from the status and trend monitoring program will be used for a variety of resource management purposes. The primary utility of the information will be the annual assessment of status and resulting trend over time for these fishes and their habitat. However, this program will also support restoration action planning and assessment by serving as the baseline information used for action siting, and the baseline against which actions' biological impact could be measured.

### b. Technical and/or scientific background

The following outline describes the basic process by which this proposal seeks to develop subbasin scale status and trend monitoring programs for anadromous salmonids and their habitat. This monitoring programs development is meant to pilot the development of a comprehensive monitoring program for the entire Columbia River basin. As such, the primary focus of this work is on the development and testing of the approach. Therefore, during program assessment and evaluation, addressing questions of how the pilot programs will scale up to cover a larger spatial extent will be critical.

The monitoring program is proposed for development in the upper Wenatchee and Grande Ronde River basins (wadeable portions of the subbasins; above Tumwater canyon in the Wenatchee and the Oregon portion of the Grande Ronde), targeting natural spawning and rearing of steelhead (*O. mykiss*) and spring chinook (*O. tshawytscha*). The spatial extent of the proposed monitoring program is limited by two major considerations, firstly the protocols being tested are specifically designed for wadeable streams, and secondly, as pilot programs the focus is on testing and development, rather than complete basin-wide coverage. In addition, by restricting the program's extent to portions of these two major each subbasin will be considered to consist of 4 major watersheds (Wenatchee: Nason, White, Little Wenatchee, Chiwawa; Grande Ronde: Wenaha, Wallowa-Lostine, Minam, Upper Grande Ronde). The division of the subbasins into major watersheds is based roughly on population structure information being developed by the Interior Columbia River Technical Recovery Team (Pers. Comm. M. McClure), and will be used primarily for organizational purposes, as well as for post-hoc stratification of data to address issues of monitoring program scale and status and trend analyses as a function of land management practices.

The Wenatchee and Grande Ronde River basins were chosen as potential monitoring pilot program locations for a variety of programmatic, logistical and biological reasons. Both basins have breeding and rearing listed and non-listed anadromous salmonid species. Listed species imply the attention and interest of resource management agencies while non-listed species might allow opportunities to develop approaches prior to implementation on listed species. Both river basins are of interest for monitoring program development by USFWS, NMFS, FCRPS Biological Opinion Action Agencies, State of Washington, State of Oregon, and others. Each river basin can be thought of as four major watersheds of similar size covering a wide range of human impacts, uses and management levels including wilderness areas as reference points, all with reasonable access. In both basins there are high quality existing status monitoring efforts against which a sampling framework could be tested. For example, in the Wenatchee there is an annual census of adult chinook populations, and the US Forest Service has conducted modified Hankin-Reeves survey of upper watersheds. While in the Grande Ronde ODFW and others have significant historical and on-going life-history and life-stage survival research. In both basins there is the potential for expanding the ability to verify difficult sampling procedures, e.g., smolt traps on major watersheds to test snorkel-based sampling. And finally, both river basins have a range of hatchery impacts, with clearly identified areas that are completely natural production watersheds.

*Outline of proposed work*

*Objective 1.*

Define cooperative agreements under which the salmonid and habitat status and trend monitoring program design, development and implementation will occur. Detailed cooperative agreements to partition the implementation of particular tasks during monitoring program development are needed. The development of the cooperative agreement will occur in parallel to the initial phases of monitoring program development (*Tasks* associated with *Objective 2*), but must be finalized prior to initiating *Tasks* associated with *Objective 3*.

*Task 1.1.*

Currently individuals and Agency members of the Upper Columbia Regional Technical Team, Interior Columbia Technical Recovery Team, Washington State Comprehensive Monitoring Strategy, Environmental Protection Agency, and the NMFS-FCRPS-BiOp-Action-Agency RME Team are participating in the coordination of monitoring program development and implementation in the Wenatchee River basin. Refine cooperative agreement between these parties (identifying other participants if necessary) to implement *Tasks* associated with *Objectives 2.1* and *3.1*.

*Task 1.2.*

Currently individuals and Agency members from Oregon Department of Fish and Wildlife, Oregon Department of Environmental Quality, Oregon Watershed Enhancement Board, Nez Perce Tribe, Confederated Tribes of the Umatilla Reservation, US Forest Service, Environmental Protection Agency, and the NMFS-FCRPS-BiOp Action Agency RME Team are participating in the coordination of monitoring program development and implementation in the Grande Ronde River basin. Refine cooperative agreement between these parties (identifying other participants if necessary) to implement *Tasks* associated with *Objectives 2.2* and *3.2*.

*Objective 2.*

Develop a salmonid population and habitat status and trend monitoring approach with known accuracy and precision through field-testing of protocols and sampling design.

*Task 2.1.* Develop and test a status monitoring program specific to the Wenatchee River basin ecosystem.

*2.1.1.* -- Test habitat assessment methods.
*2.1.2.* -- Test adult population assessment methods.
*2.1.3.* -- Test juvenile population/productivity assessment methods.
*2.1.4.* -- Test probabilistic sampling based approaches.

*Task 2.2.* Develop and test a status monitoring program specific to the Grande Ronde River basin ecosystem.

*2.2.1.* -- Test habitat assessment methods.
*2.2.2.* -- Test adult population assessment methods.
*2.2.3.* -- Test juvenile population/productivity assessment methods.
*2.2.4.* -- Test probabilistic sampling based approaches.

*Objective 3.*

Implement the salmonid and habitat status and trend monitoring program developed in *Objective 2* through the cooperative agreement developed in *Objective 1*.

*Task 3.1.*

Implement a pilot status and trend monitoring program for salmonids and their habitat in the Wenatchee River basin.

*Task 3.2.*

Implement a pilot status and trend monitoring program for salmonids and their habitat in the Grande Ronde River basin.

*Scientific and programmatic background*

There have been numerous recent administrative and scientific calls for a comprehensive monitoring and evaluation program to provide consistent, region-wide information about the status of salmon populations and their response to management actions (Botkin *et al.* 2000, ISAB 2001, RSRP 2001). In addition, the 2000 Biological Opinion on the Federal Columbia River Power System requires the development and implementation of a coordinated monitoring and evaluation program (NMFS 2000a). The call for developing a consistent, region-wide monitoring program has been strong and widespread because once implemented, such a program will address a number of outstanding scientific agendas. First, it will provide a scientifically robust method to evaluate the status of populations and ESUs, and thereby gauge progress toward recovery goals, such as the de-listing criteria defined by the regional TRT's (NMFS 2000b). Second, it provides the means to develop and refine appropriate performance measures and standards for conservation actions. Finally, it will provide managers with the tools to assess quantitatively the impact of single or composite actions on fish populations, thereby increasing our ability to conduct effective recovery planning.

The pilot status and trend monitoring program proposed here will address not only these scientifically-based policy agendas, but will also provide the framework in which to address a substantive administrative issue – implementing the requirements for developing the monitoring and evaluation program outlined in the NMFS 2000 Biological Opinion on the Federal Columbia River Power System (Actions 180-184, 188, 190, 191, 193, and 195-7), specifically, population and habitat status monitoring for anadromouns salmonids as required under Action Item 180.

A well-designed monitoring and evaluation program is a critical component of any conservation or restoration activity. Monitoring is vital in determining whether specific management actions have been effective, and large-scale monitoring and evaluation is important in assessing the success of integrated actions having achieved desired population size, distribution and trends. Moreover, well-coordinated management actions, when coupled with relevant monitoring and evaluation programs, can reduce uncertainty about the effect of those actions on population productivity.

The primary goal of this monitoring and evaluation effort is to design and implement a system of statistically rigorous data collection schemes to answer questions fundamental to the management and recovery of anadromous salmonids. In spite of tremendous past efforts many of the most important questions remain unanswered due to basic uncertainties in these fishes' population processes, both with respect to trends in abundance as well as the factors that regulate salmonid population dynamics.

At present there are a number of high-quality population and habitat monitoring and assessment programs within the Columbia River Basin (e.g. Oregon Plan 1997; Alverts *et al.* 1997, CBFWA 2001). However, none of these programs has both comprehensive geographic coverage and a sampling theoretic basis. In particular, there are no comprehensive guidelines to be drawn from these plans that can be used as a template for monitoring the status and recovery of impacted populations as well as their breeding, rearing and migratory corridor habitat in the entire Columbia River Basin. At issue is both the type of data traditionally collected to assess population and habitat status, as well as the manner by which the data collection scheme is implemented in time and space.

The primary objective of this proposed status monitoring plan for Columbia River Basin is a statistically sound sampling design that when implemented will generate useful data with known analytical and predictive power. Several technical challenges are immediately apparent, and this work is distinct from previous efforts in how we will approach these challenges. The primary complication arises from the enormous spatial scale and resulting heterogeneity of the sampling areas and indicators. As such, the manner of population and habitat sampling, and the manner in which the samples are distributed in time and space, will strongly influence the assessment of status and effectiveness. To satisfy this constraint requires considerable knowledge of both the spatial extent of true demographic units and the mechanisms of population regulation, potentially more than we currently posses. However, lacking these key pieces of information does not mean that we are unable to accurately assess population and habitat status, but it does mean that we must do so under a modern and statistically rigorous sampling program informed by our knowledge of demographic and habitat processes. This work is intended to develop and test status and trend monitoring approaches capable of the statistical rigor specifically required by the region's natural resource management agencies and personnel.

**c. Rationale and significance to Regional Programs**

This proposed work directly addresses calls for the development of salmonid population and habitat monitoring programs in the NWPPC's Fish and Wildlife Program (NWPPC 2000), CBFWA's Program Summaries for the Mainstem/Systemwide Province (Jordan et al. 2002), Federal Caucus Basinwide Salmon Recovery Strategy (Federal Caucus 2000,) and the NMFS Biological Opinion on the Operation and Maintenance of the Federal Columbia River Power System (NMFS 2000a).

Of particular relevance are the requests for proposals to help meet BPA's obligations under the NMFS FCRPS Biological Opinion for a population and habitat status monitoring program for listed anadromous salmonids in the Columbia River basin (statusmonitorrpa180.pdf, FutureNeeds.pdf, GapAnalysis.pdf). The NMFS 2000 FCRPS Biological Opinion outlines basinwide status monitoring programmatic needs, and performance standards for the monitoring program. At an absolute minimum the anadromous salmonid status monitoring program for the Columbia River Basin must collect data that can be used to answer the following four questions. These questions arise as specific requirements for assessing the status of ESA listed salmonid species in the Columbia River Basin (NMFS 2000 FCRPS BO, 9.2.2.1).

1. Is the annual population growth rate greater in 2005 and 2008 than during the base period (1980 – 2000)?
2. Is the annual population growth rate in 2005 and 2008 greater than or equal to the projected growth rate based on improvements made and expected from actions taken in the 1995 biological opinion, reductions in harvest that occurred after the base period, and the survival standards in the Mid-Columbia Habitat Conservation Plan.
3. Is the annual population growth rate in 2005 and 2008 equal to or greater than the projected growth rates necessary to achieve the 48-year recovery criteria.
4. Is the annual adult return of wild fish as represented by the 5-year geometric mean for each ESU and population greater than the ESU and population size (5-year geometric mean) in 2000?

In addition, RPAs 9, 180, 181, 198, of the FCRPS Biological Opinion directly address the responsibilities of the Action Agencies and other regional entities for the development of system-wide fish and habitat status monitoring. In addition to information needed to address these population level questions for ESA listed populations, the Action Agencies and the region will require information to assess progress toward performance standards for the hydro corridor and for tributary, mainstem, and estuary habitat conditions. Thus, the development of the status monitoring program must be within the context of a Columbia River basin-wide research, monitoring and evaluation plan. Furthermore, the research, monitoring and evaluation program will be supported by a regional data management system to facilitate the collection, analysis and dissemination of the monitoring data.

### d. Relationships to other projects

This is a new program request, however, it is strongly based on the status and trend monitoring work currently underway in the Oregon Columbia Plateau (BPA #25088). This work will also draw on the statistical approaches and field protocols utilized by Oregon Department of Environmental Quality (e.g., BPA #25010). This project proposal is also linked to others being submitted for consideration under the Mainstem/Systemwide Provincial Review Process. These proposals (*A Pilot Study to Test Links Between Land Use / Land Cover Tier 1 Monitoring Data and Tier 2 and 3 Monitoring*, Feist; *Regional Project Effectiveness Monitoring Program for Columbia River Basin Listed Anadromous Salmonids*, Katz; NWFWC *Salmon Data Management, Analysis and Access for Research, Monitoring and Evaluation Programs*, Kang), together with this proposal, form a pilot program approach to a comprehensive status and effectiveness monitoring program for Columbia River basin salmonids and their habitat. This suite of proposals aims to implement the critical missing components (status monitoring, effectiveness monitoring and data management) of a regional Research, Monitoring and Evaluation program as called for in the 2000 NMFS FCRPS Biological Opinion (RPA Action Items 180, 181, 183 and 198).

The status monitoring program development as proposed herein will require extensive collaborative work with ongoing research and monitoring programs. The design and testing phase for this project will require collaboration with US Environmental Protection Agency research staff. For field work and implementation of the program in the Wenatchee River basin the Principal Investigator will work directly with the following ongoing efforts: US Forest Service's Aquatic Habitat survey program, Chelan County PUD's juvenile salmonid sampling program, Washington Department of F&W's juvenile and adult salmonid sampling program, Washtington Department of Ecology's Regional Environmental Monitoring and Assessment Program. For field work and implementation of the program in the Grande Ronde River basin the Principal Investigator will work directly with the following ongoing efforts: Oregon Department of F&W's juvenile and adult salmonid sampling program, US Forest Service's environmental monitoring programs. In both river basins additional Tribal, State and Federal partnerships will be possible, and highly beneficial to the outcome of this work.

**e. Project history** (for ongoing projects)

This is a new project.

**f. Proposal objectives, tasks and methods**

A comprehensive status monitoring program should address the three major attributes of fish populations and their habitats that together provide indicators of ecosystem productivity and resilience in the face of environmental uncertainty: (1) The absolute *abundance and survival* of fish populations and their trends through time (e.g., indicators of productivity); (2) The *geographic patterns* (e.g., spatio-temporal distribution, genetic, and life-history diversity) of populations relative to their habitats (e.g., indicators of biological adaptation in a heterogeneous environment); and (3) The *variance* of populations through time (e.g., an indicator of resilience). In addition to these population indicators, the program also requires an understanding of (4) *ecological processes* such as climatic, hydrologic, or biotic interactions that naturally cause changes in fish populations. Indicators of these processes are critical to determine whether population responses are due to restoration activities, unrelated fluctuations in the natural environment, or some interaction of these effects. Failure to account for the background processes of variation may lead to erroneous conclusions about the success or failure of recovery measures. The status monitoring program proposed for development will explicitly address these four critical attributes of salmonid populations and habitat. Generating data to assess these four attributes requires a monitoring program that is designed with the specifics of these fishes natural history in mind, as well as a detailed knowledge of their geographic distribution and its spatio-temporal dependence on landscape scale features and ecological processes. Lacking these critical components that underlie the design process requires and explicit design phase to elucidate these important determinants of the performance of the proposed monitoring program. Developing this monitoring program will involve a 3-step process, the components of which are organizational, logistical, statistical and biological. The three primary steps are detailed below, expressed as *Objectives* with associated *Tasks* and *Methods*. The *Objectives* are sequentially arranged, but could be implemented in a somewhat parallel or phased manner.

*Objective 1.*

Define cooperative agreements under which the salmonid and habitat status and trend monitoring program design, development and implementation will occur. Detailed cooperative agreements to partition the implementation of particular tasks during monitoring program development are needed. The development of the cooperative agreement will occur in parallel to the initial phases of monitoring program development (*Tasks* associated with *Objective 2*), but must be finalized prior to initiating *Tasks* associated with *Objective 3*.

*Task 1.1.*

Currently individuals and Agency members of the Upper Columbia Regional Technical Team, Interior Columbia Technical Recovery Team, Washington State Comprehensive Monitoring Strategy, and the NMFS-FCRPS-BiOp-Action-Agency RME Team are participating in the coordination of monitoring program development and implementation in the Wenatchee River basin. Refine cooperative agreement between these parties (identifying other participants if necessary) to implement *Tasks* associated with *Objectives 2* and *3*.

*Methods 1.1.*

The Principal Investigator will continue to work collaboratively with the identified agency personnel to develop a cooperative agreement for the implementation of the on-the-ground portions of this work. Current informal agreements will be formalized in the form of statements of work and subcontracts. The bulk of the work required in the *Tasks* associated with *Objectives 2* and *3* will be subcontracted from NMFS-NorthWest Fisheries Science Center, or if possible, developed as separate contracts during the contract negotiation phase with BPA.

*Task 1.2.*

Currently individuals and Agency members from Oregon Department of Fish and Wildlife, Oregon Department of Environmental Quality, Oregon Watershed Enhancement Board, Nez Perce Tribe, Confederated Tribes of the Umatilla Reservation, and the NMFS-FCRPS-BiOp Action Agency RME Team are participating in the coordination of monitoring program development and implementation in the Grande Ronde River basin. Refine cooperative agreement between these parties (identifying other participants if necessary) to implement *Tasks* associated with *Objectives 2* and *3*.

*Methods 1.2.*

The Principal Investigator will continue to work collaboratively with the identified agency personnel to develop a cooperative agreement for the implementation of the on-the-ground portions of this work. Current informal agreements will be formalized in the form of statements of work and subcontracts. The bulk of the work required in the *Tasks* associated with *Objectives 2* and *3* will be subcontracted from NMFS-NorthWest Fisheries Science Center, or if possible, developed as separate contracts during the contract negotiation phase with BPA.

*Objective 2.*

Develop a salmonid population and habitat status and trend monitoring approach with known accuracy and precision through field-testing of protocols and sampling design.

*Task 2.1.* -- Develop and test a status monitoring program specific to the Wenatchee River basin ecosystem.

The testing and development of habitat assessment methods involves three components: assessing the measurement error associated with the recommended protocols, quantifying the spatio-temporal variance components for each indicator based on recommended sampling program coverage, and assessing the information content of the indicators given uncertainty in indicator value due to sampling/measurement/process error and correlation of indicator to salmonid population abundance/productivity metrics. The three components of this task are accomplished within a single field-testing framework by implementing a suite of habitat indicator protocols under a variety of sampling regimens.

A key feature of the testing framework is the use of census or validation reaches. These are locations where the indicator in question is known with high accuracy and precision through extensive sampling or a census independent of the protocol testing process. For example, for habitat survey method testing in the absence of any background information or other monitoring programs, a reach is chosen that represents the diversity of natural conditions to be encountered in a random sampling of the watershed. The validation reach is then extensively mapped by expert personnel other than those on project field crews. This reach can then be used as a test case, since the 'true' value of its habitat indicators are known. Alternatively, in locations with smolt traps, or exhaustive adult spawning surveys, these areas will represent 'true' values against which indicator and sampling protocols can be assessed.

With validation reaches it is reasonably straightforward to design test for protocols, crews and sampling schemes. Measurement error is assessed absolutely for a crew or protocol by sampling within the area of known habitat indicator values. For relative measurement error between crews or protocols, resampling of randomly chosen reaches will be used, provided the resampling is done within 7 days of the initial pass. Important components of the variance structure of indicators can be determined by resampling on a variety of spatio-temporal scales (Larsen et al. 2001). On some spatio-temporal scales all habitat and population indicators will be highly autocorrelated (e.g., two points in a watershed separated by several meters are more likely to be similar than two point separated by 100s of meters). However, while such spatio-temporal similarities should generally decay with increasing time/distance, there are numerous situations where this is not the general case (e.g., periodic patterns due to ocean/climate cycles or strong brood year cycles). Therefore, to properly assess the spatio-temporal component of habitat and population indicator variance, a component of the sampling program should always be within and between years and watersheds. Finally, to determine the natural resource management value, or information content, of each monitoring variable or indicator, habitat and population indicator sampling will be conducted within an analytical evaluation framework. Simultaneously constructing and testing hierarchical correlative models of habitat indicators and population processes will support the development of both the data collection process and the evaluation of monitoring data in a management context. Validation or census reaches will be particularly valuable in this context as the predictive power of random variables is strongly determined by their error term (Holmes 2001, Holmes and Fagan 2002)– data collection associated with validation/census areas allows for the further partitioning of the variance terms discussed above into their process and non-process components.

*Subtask 2.1.1.* -- Test habitat assessment methods.

*Methods 2.1.1.* -- Habitat and Riparian Survey

Ideally, channel habitat and riparian surveys will be conducted as described by Moore et al. (1997). However, modification will be required to adapt these methods to the Wenatchee River basin. Some known modifications will include: survey lengths of 500-1000m and measurement of all habitat unit lengths and widths (as opposed to estimation; based on experience with these methods, Thom et al. 1999, 2000, 2001). Additional modifications will arise due to field-testing of methods and measurement error estimation approach described below.

Survey teams will collect field data based on stream, reach, and channel unit characteristics. Each field crew is comprised of two people with each member responsible for specific tasks. The "Estimator" will focus on the identification of channel unit characteristics. The "Numerator" will focus on the counts and relative distribution of several unit attributes and will verify the length and width estimates for a subset of units. The "Estimator" and "Numerator" share the responsibility for describing reach characteristics, riparian conditions, identifying habitat unit types, and for quantifying the amount of large woody debris. Crewmembers may switch responsibility for estimator or numerator when they start a new stream. They will not, however, switch estimator and numerator jobs on the same stream. The methods and indicator variables collected with this protocol can be viewed at http://osu.orst.edu/Dept/ODFW/freshwater/inventory/pdffiles/habmethod.pdf.

To quantify within-season habitat variation and differences in estimates between survey crews, sites will be resampled with a separate two-person crew. Repeat surveys will be a randomly selected sub-sample from each survey crew. Variation in survey location was assumed minimal because survey starting and ending points were marked in the field. The precision of individual metrics will be calculated using the mean variance of the resurveyed streams “Noise” and the overall variance encountered in the habitat surveys “Signal”. Three measures of precision are calculated, the standard deviation of the repeat surveys SDrep, the coefficient of variation of the repeat surveys (CVrep), and the signal to noise ratio (S:N). S:N ratios of < 2 can lead to distorted estimates of distributions and limit regression and correlation analysis. S:N ratios > 10 have insignificant error caused by field measurements and short term habitat fluctuations (Kauffman et al. 1999).

Habitat conditions will be described using a series of cumulative distributions of frequency (CDF). The variables described are indicators of habitat structure, sediment supply and quality, riparian forest connectivity and health, and in-stream habitat complexity. The specific attributes are:

Density of woody debris pieces (> 3 m length, >0.15 m diameter)
Density of woody debris volume (> 3 m length, >0.15 m diameter)
Density of key woody debris pieces (>10 m length, >0.6 m diameter)
Density of wood jams (groupings of more than 4 wood pieces)
Density of deep pools (pools >1 m in depth)
Percent pool area
Density of riparian conifers (>0.5 m DBH) within 30 m of the stream channel
Percent of channel shading (percent of 180 degrees)
Percent of substrate area with fine sediments (<2 mm) in riffle units
Percent of substrate area with gravel (2-64 mm) in riffle units

While these attributes do not describe all of the conditions necessary for high quality salmonid habitat, they do describe important attributes of habitat structure within and adjacent to the stream channel. The attributes are also indicative of streamside and upland processes. Water quality and quantity, as well as food production, are not addressed in the discussion ofphysical habitat, but are critical elements for the Oregon Department of Environmental Qualities EMAP program. The median and first and third quartiles will be used to describe the range and central tendencies of the frequency distributions of the key habitat attributes used in the analysis of current habitat conditions (Zar 1984). Frequency distributions will be tested to determine if significant differences ($p<0.05$) exist between subbasins for each habitat attribute (Thom et al. 2000). The information content, or predictive power of the habitat indicators will be assessed within a hierarchical modeling framework to test the extent of correlation between habitat indicators and fish indicators within and between baseline reaches and sampling reaches.

*Subtask 2.1.2.* -- Test adult population assessment methods.

*Methods 2.1.2.* -- Adult Steelhead and Spring Chinook Redd Surveys
The Wenatchee River basin has considerable adult survey work currently underway to exhaustively enumerate adult spring Chinook. The development of a probabilistic sampling scheme for redd counts is meant to complement this work, if the methods prove sufficiently accurate and precise for regional needs. The key

to testing the following sampling based approaches will be the ongoing census based surveys that will act as the ‘truth’ against with the sampling data can be compared. For steelhead surveys, the testing will focus on the protocol/method development due to the logistical difficulty of surveying these fishes during the spring. In this case, assessments of population status could be strongly influence by uncontrolled measurement error. Methods for assessing the accuracy and precision of steelhead redd surveys will be developed in conjunction with adult counting facilities (e.g. explore potential for instrumenting Tumwater Dam).

Fifty sites will be selected for each subbasin and are visited on a bi-weekly basis throughout the season to quantify the cumulative redd count at each site. At each sample site, the sample reach is split in two with each surveyor responsible for one half of the survey. Each surveyor samples upstream from the downstream end of each survey reach. Each surveyor counts live fish and determines the fin-mark status of all live fish through observations. All redds are counted, flagged and rocked with a painted rock. Data are recorded on the spawning survey form, redd longevity form, and spawning location description form. Survey crews review survey forms daily and deliver hard copies bi-weekly to the crew chief. Crew chiefs conduct weekly site visits with each crew. Data entry is conducted as time allows throughout the survey season and is completed within one month of the end of fieldwork. The population status will be indexed through cumulative redd counts. Expected precision at the provincial scale will be ±25% and ±40% at the subbasin scale. Hatchery: wild ratios will be estimated by observing the occurrence of adipose fin-clipped and unmarked live fish on spawning grounds.

To quantify observer error we will implement the following procedures. Each site is visited bi-weekly with the surveyors swapping sample reaches every survey. The surveyor records the number of flagged/rocked redds, new redds, and redds missed during the previous survey. Missed redds are distinguished from new redds by the amount of periphytic growth in the redd pocket. New redds will be devoid of periphyton whereas older redds become obscured by periphytic growth. The independent estimate of marked versus unmarked redds from survey to survey will provide an estimate of the error associated with identifying steelhead redds. To validate whether cumulative redd counts are a reliable indicator of populations status, we will compare subbasin redd estimates to steelhead populations estimates from dam/ladder/weir/census counts, comparing population estimates from census methods to survey estimates. In addition, we will begin exploring where we can develop the data to allow the conversion of redd counts to population estimates. The necessary data would include the sex ratio of returning adults and redd:female ratios.

Where the subbasin has on-going index surveys, assess the cost/information gained relationship for index surveys, census methods and probabilistic sampling. To fully explore this issue, develop a dataset that covers the range of abundance seen under the historic index surveys to examine the relationship between the three methods. From this analysis we should be able to develop a strong relationship that will allow us to index the historic surveys to the probabilistic surveys, and assess the best monitoring program for the future. This will take an unknown length of time but will probably be on the order of 5-10 years.

*Subtask 2.1.3* -- Test juvenile population/productivity assessment methods.

*Methods 2.1.3.* -- Juvenile Salmonid Survey

Ideally, juvenile salmonid monitoring will be accomplished by snorkel surveys involving a single upstream pass through each pool during daylight along a 1-km survey reach. This approach will be assessed and modified as needed to adopt the following methods to the Wenatchee River basin.

For single pass snorkel surveys the number of snorkelers employed will be based on what is needed to effectively cover the pool being snorkeled on a single upstream pass. To reduce problems associated with snorkeling in shallow or fast water habitat, only pools $\geq$ 6 $m^2$ in surface area and $\geq$ 40 cm deep are snorkeled. Counts of the number of juvenile and adult trout (*O. mykiss*) and salmon (*O. tshawytscha*) are recorded for each pool. Trout and salmon will be categorized as fry (0 year class), juvenile (1+ years or greater), or adult based on size classes developed from local data and/or standards. Other species will be noted as present and recorded. Crewmembers either alternate the pools that they snorkel or one crewmember snorkels the entire reach. After snorkeling, the underwater visibility of each pool during the snorkel count is ranked on a scale of 0 to 3 where: 0 = not snorkelable due to an extreme amount of hiding cover or zero water visibility; 1 = high amount of hiding cover or poor water clarity; 2 = moderate amount of hiding cover or moderate water clarity neither of which were thought to impede accurate fish counts; and 3 = little hiding cover and good water clarity. Only pools with a visibility rank of two or three are used in data analysis. If all pools in a reach have visibilities < 2, then as many pools in the reach as possible will be electrofished using Smith-Root model 12-B backpack electrofishers following NMFS electrofishing guidelines for juvenile salmonid presence/absence. Electrofishing will be conducted by making a single pass upstream in each pool that meets the size and depth criteria for conducting snorkel surveys. No block nets will be used for this sampling. Electrofishing data will be used to determine the presence and percent of pools occupied by juvenile *O. mykiss* and spring chinook.

To quantify the measurement error in the snorkel data, and to provide information on temporal changes in abundance during the course of the sampling season, supervisory staff will resurvey a random sample of 10 to 20 percent of the sites surveyed in each subbasin. The goal is to limit between diver error to ± 20% or less with intensive presurvey training of field crews and regular random resurveys.

Data analysis will involve calculating the percentage of survey sites that contain at least one juvenile fish for *O. mykiss* and spring chinook and the percentage of pools per site that contain juvenile *O. mykiss* and spring chinook to quantify changes in the relative distribution interannually. Analysis from coastal watersheds indicate that snorkeling data from pools has the strongest explanatory power regarding the overall trend in juvenile steelhead and coho populations (Pers. Comm, Jeff Rodgers, ODFW Research Lab, Corvallis). We will quantify the number of juvenile *O. mykiss* and spring chinook observed per square meter for use in population trend analysis within and among individual subbasins. Confidence limits for summary estimates will be developed based on quantifying the measurement error in the snorkel data (see paragraph above) and site-to-site variability based on a variance estimator developed by the EPA EMAP Program for this application (Pers. Comm. Don Stevens, EPA Research Lab, Corvallis).

*Subtask 2.1.4* -- Test probabilistic sampling based approaches.

*Methods 2.1.4.* -- Sampling methods, domains and site selection

Based on current environmental monitoring programs (U.S. EPA 1998, 2000, Oregon Plan 1997, WA CMS 2001), and scientific review of proposed salmonid and habitat monitoring programs (ISRP reviews of numerous proposals across several provinces) the sampling framework adopted for testing in this project is the US Environmental Protection Agency's EMAP. While the program has been implemented regionally for water quality monitoring (U.S. EPA 2000) and salmonid population and habitat monitoring (Oregon Plan), there are a number of aspects of the sampling frame that should be tested prior to program implementation in each new ecoregion. Therefore, while an EMAP sampling framework will underlie the development of this monitoring program, concomitant testing of the sampling program design will occur.

In cooperation with co-managers and other interested parties, this project will annually refine the sampling universe for habitat and juvenile surveys based on current distribution maps. The sampling domain is defined at the upper ends of watersheds by perennial streams and at the lower end by the capability of field crews to snorkel the sample reach. Juvenile salmonids will be inventoried at all sites within the summer rearing distribution of juvenile *O. mykiss* and spring chinook in snorkelable streams below known barriers to upstream migration. Sample sites will be derived from the 1:100k EPA River Reach file. In previous applications of EMAP to salmonid population and habitat monitoring (Jones et al. 2001, Jacobs et al. 2001), a non-uniform sampling universe was constructed. To compensate for the unequal numbers of stream miles per order (e.g., there are more 1$^{st}$ order streams than 5$^{th}$ in a single watershed), samples were distributed by stream order with unequally probability. Since stream network geometry is a strong function of gradient, geology and precipitation, the weighting of streams in the sampling scheme should be tested for each major subbasin.

To balance the needs of status (more random sites) and trend (more repeat sites) monitoring, EMAP based sampling programs generally implement a rotating panel design (general recommendations from the EPA EMAP Design Group;

Pers. Comm. P. Larsen, EPA, Corvallis). Thus, for a subbasin scale program 50 sites drawn on an annual basis for each would be assigned to the rotating panel design as follows:

- 3 panels with different repeat intervals
- 17 of the sites will be sampled every year
- 16 sites will be allocated to a 4 year rotating panel (sites visited once every 4 years on a staggered basis)
- 17 sites will be new sites each year

With this sampling strategy, 50 sites will be drawn the first year and 33 new sites will be drawn in subsequent years because 17 of the originally drawn sites will be repeated each year. The rotating panel approach is in a sense a bet-hedging strategy, distributing samples between random and fixed sites due to an incomplete understanding of the spatio-temporal variance structure of the monitoring program's indicators. An explicit goal of this program will be to collect all indicator data in the variance partitioning framework outlined in *Task 2.1* to test the efficiency of the rotating panel approach, and the fraction of sites distributed to fixed and random categories.

Similarly, there is nothing "magical" about 50 samples per subbasin since precision increases gradually with increase in sample size. For the most part, we want a good estimate of the variance of our target population. Small sample sizes give poor estimates of the variance, and with small samples, random draws can be quite a bit off from the actual population's characteristics (mean, variance, median). Fifty is a rule of thumb to get a reasonably good picture. Another reasonably good rule of thumb is that doubling precision requires a four-fold increase in sample size. So if you get a particular precision at 50 samples, you'd need 200 samples to double precision. However, once again, 50 samples is an initial guess that can be refined with data collection on indicator variance structure.

*Task 2.2.* -- Develop and test a status monitoring program specific to the Grande Ronde River basin ecosystem.

The testing and development of habitat assessment methods involves three components: assessing the measurement error associated with the recommended protocols, quantifying the spatio-temporal variance components for each indicator based on recommended sampling program coverage, and assessing the information content of the indicators given uncertainty in indicator value due to sampling/measurement/process error and correlation of indicator to salmonid population abundance/productivity metrics. The three components of this task are accomplished within a single field-testing framework by implementing a suite of habitat indicator protocols under a variety of sampling regimens.

A key feature of the testing framework is the use of census or validation reaches. These are locations where the indicator in question is known with high accuracy and precision through extensive sampling or a census independent of the protocol testing process. For example, for habitat survey method testing in the absence of any background information or other monitoring programs, a reach is chosen that represents the diversity of natural conditions to be encountered in a random sampling of the watershed. The validation reach is then extensively mapped by expert personnel other than those on project field crews. This reach can then be used as a test case, since the 'true' value of its habitat indicators are known. Alternatively, in locations with smolt traps, or exhaustive adult spawning surveys, these areas will represent 'true' values against which indicator and sampling protocols can be assessed.

With validation reaches it is reasonably straightforward to design test for protocols, crews and sampling schemes. Measurement error is assessed absolutely for a crew or protocol by sampling within the area of known habitat indicator values. For relative measurement error between crews or protocols, resampling of randomly chosen reaches will be used, provided the resampling is done within 7 days of the initial pass. Important components of the variance structure of indicators can be determined by resampling on a variety of spatio-temporal scales (Larsen et al. 2001). On some spatio-temporal scales all habitat and population indicators will be highly autocorrelated (e.g., two points in a watershed separated by several meters are more likely to be similar than two point separated by 100s of meters). However, while such spatio-temporal similarities should generally decay with increasing time/distance, there are numerous situations where this is not the general case (e.g., periodic patterns due to ocean/climate cycles or strong brood year cycles). Therefore, to properly assess the spatio-temporal component of habitat and population indicator variance, a component of the sampling program should always be within and between years and watersheds. Finally, to determine the natural resource management value, or information content, of each monitoring variable or indicator, habitat and population indicator sampling will be conducted within an analytical evaluation framework. Simultaneously constructing and testing hierarchical correlative models of habitat indicators and population processes will support the development of both the data collection process and the evaluation of monitoring data in a management context. Validation or census reaches will be particularly valuable in this context as the predictive power of random variables is strongly determined by their error term (Holmes 2001, Holmes and Fagan 2002)– data collection associated with validation/census areas allows for the further partitioning of the variance terms discussed above into their process and non-process components.

*Subtask 2.2.1.* -- Test habitat assessment methods.

*Methods 2.2.1.* -- Habitat and Riparian Survey

Ideally, channel habitat and riparian surveys will be conducted as described by Moore et al. (1997). However, modification will be required to adapt these methods to the Grande Ronde River basin. Some known modifications will include: survey lengths of 500-1000m and measurement of all habitat unit lengths and widths (as opposed to estimation; based on experience with these methods, Thom et al. 1999, 2000, 2001). Additional modifications will arise due to field-testing of methods and measurement error estimation approach described below.

Survey teams will collect field data based on stream, reach, and channel unit characteristics. Each field crew is comprised of two people with each member responsible for specific tasks. The "Estimator" will focus on the identification of channel unit characteristics. The "Numerator" will focus on the counts and relative distribution of several unit attributes and will verify the length and width estimates for a subset of units. The "Estimator" and "Numerator" share the responsibility for describing reach characteristics, riparian conditions, identifying habitat unit types, and for quantifying the amount of large woody debris. Crewmembers may switch responsibility for estimator or numerator when they start a new stream. They will not, however, switch estimator and numerator jobs on the same stream. The methods and indicator variables collected with this protocol can be viewed at http://osu.orst.edu/Dept/ODFW/freshwater/inventory/pdffiles/habmethod.pdf.

To quantify within-season habitat variation and differences in estimates between survey crews, sites will be resampled with a separate two-person crew. Repeat surveys will be a randomly selected sub-sample from each survey crew. Variation in survey location was assumed minimal because survey starting and ending points were marked in the field. The precision of individual metrics will be calculated using the mean variance of the resurveyed streams “Noise” and the overall variance encountered in the habitat surveys “Signal”. Three measures of precision are calculated, the standard deviation of the repeat surveys SDrep, the coefficient of variation of the repeat surveys (CVrep), and the signal to noise ratio (S:N). S:N ratios of < 2 can lead to distorted estimates of distributions and limit regression and correlation analysis. S:N ratios > 10 have insignificant error caused by field measurements and short term habitat fluctuations (Kauffman et al. 1999).

Habitat conditions will be described using a series of cumulative distributions of frequency (CDF). The variables described are indicators of habitat structure, sediment supply and quality, riparian forest connectivity and health, and in-stream habitat complexity. The specific attributes are:

Density of woody debris pieces (> 3 m length, >0.15 m diameter)
Density of woody debris volume (> 3 m length, >0.15 m diameter)
Density of key woody debris pieces (>10 m length, >0.6 m diameter)
Density of wood jams (groupings of more than 4 wood pieces)
Density of deep pools (pools >1 m in depth)
Percent pool area
Density of riparian conifers (>0.5 m DBH) within 30 m of the stream channel
Percent of channel shading (percent of 180 degrees)

Percent of substrate area with fine sediments (<2 mm) in riffle units
Percent of substrate area with gravel (2-64 mm) in riffle units

While these attributes do not describe all of the conditions necessary for high quality salmonid habitat, they do describe important attributes of habitat structure within and adjacent to the stream channel. The attributes are also indicative of streamside and upland processes. Water quality and quantity, as well as food production, are not addressed in the discussion ofphysical habitat, but are critical elements for the Oregon Department of Environmental Qualities EMAP program. The median and first and third quartiles will be used to describe the range and central tendencies of the frequency distributions of the key habitat attributes used in the analysis of current habitat conditions (Zar 1984). Frequency distributions will be tested to determine if significant differences ($p<0.05$) exist between subbasins for each habitat attribute (Thom et al. 2000). The information content, or predictive power of the habitat indicators will be assessed within a hierarchical modeling framework to test the extent of correlation between habitat indicators and fish indicators within and between baseline reaches and sampling reaches.

*Subtask 2.2.2.* -- Test adult population assessment methods.

*Methods 2.2.2.* -- Adult Steelhead and Spring Chinook Redd Surveys
The Grande Ronde River basin has considerable adult survey work currently underway to enumerate adult spring Chinook and steelhead. The development of a probabilistic sampling scheme for redd counts is meant to complement this work, if the methods prove sufficiently accurate and precise for regional needs. The key to testing the following sampling based approaches will be the ongoing census based surveys that will act as the ‘truth’ against with the sampling data can be compared. For steelhead surveys, the testing will focus on the protocol/method development due to the logistical difficulty of surveying these fishes during the spring. In this case, assessments of population status could be strongly influence by uncontrolled measurement error. Methods for assessing the accuracy and precision of steelhead redd surveys will be developed in conjunction with adult counting facilities.

Fifty sites will be selected for each subbasin and are visited on a bi-weekly basis throughout the season to quantify the cumulative redd count at each site. At each sample site, the sample reach is split in two with each surveyor responsible for one half of the survey. Each surveyor samples upstream from the downstream end of each survey reach. Each surveyor counts live fish and determines the fin-mark status of all live fish through observations. All redds are counted, flagged and rocked with a painted rock. Data are recorded on the spawning survey form, redd longevity form, and spawning location description form. Survey crews review survey forms daily and deliver hard copies bi-weekly to the crew chief. Crew chiefs conduct weekly site visits with each crew. Data entry is conducted as time allows throughout the survey season and is completed within one month of the end of fieldwork. The population status will be indexed through cumulative redd counts. Expected precision at the provincial scale will be ±25% and ±40% at the subbasin scale. Hatchery: wild ratios will be estimated by observing the occurrence of adipose fin-clipped and unmarked live fish on spawning grounds.

To quantify observer error we will implement the following procedures. Each site is visited bi-weekly with the surveyors swapping sample reaches every survey. The surveyor records the number of flagged/rocked redds, new redds, and redds missed during the previous survey. Missed redds are distinguished from new redds by the amount of periphytic growth in the redd pocket. New redds will be devoid of periphyton whereas older redds become obscured by periphytic growth. The independent estimate of marked versus unmarked redds from survey to survey will provide an estimate of the error associated with identifying steelhead redds. To validate whether cumulative redd counts are a reliable indicator of populations status, we will compare subbasin redd estimates to steelhead populations estimates from dam/ladder/weir/census counts, comparing population estimates from census methods to survey estimates. In addition, we will begin exploring where we can develop the data to allow the conversion of redd counts to population estimates. The necessary data would include the sex ratio of returning adults and redd:female ratios.

Where the subbasin has on-going index surveys, assess the cost/information gained relationship for index surveys, census methods and probabilistic sampling. To fully explore this issue, develop a dataset that covers the range of abundance seen under the historic index surveys to examine the relationship between the three methods. From this analysis we should be able to develop a strong relationship that will allow us to index the historic surveys to the probabilistic surveys, and assess the best monitoring program for the future. This will take an unknown length of time but will probably be on the order of 5-10 years.

*Subtask 2.2.3* -- Test juvenile population/productivity assessment methods.

*Methods 2.2.3.* -- Juvenile Salmonid Survey
Ideally, juvenile salmonid monitoring will be accomplished by snorkel surveys involving a single upstream pass through each pool during daylight along a 1-km survey reach. This approach will be assessed and modified as needed to adopt the following methods to the Grande Ronde River basin.

For single pass snorkel surveys the number of snorkelers employed will be based on what is needed to effectively cover the pool being snorkeled on a single upstream pass. To reduce problems associated with snorkeling in shallow or fast water habitat, only pools $\geq$ 6 $m^2$ in surface area and $\geq$ 40 cm deep are snorkeled. Counts of the number of juvenile and adult trout (*O. mykiss*) and salmon (*O. tshawytscha*) are recorded for each pool. Trout and salmon will be categorized as fry (0 year class), juvenile (1+ years or greater), or adult based on size classes developed from local data and/or standards. Other species will be noted as present and recorded. Crewmembers either alternate the pools that they snorkel or one crewmember snorkels the entire reach. After snorkeling, the underwater visibility of each pool during the snorkel count is ranked on a scale of 0 to 3 where: 0 = not snorkelable due to an extreme amount of hiding cover or zero water visibility; 1 = high amount of hiding cover or poor water clarity; 2 = moderate amount of hiding cover or moderate water clarity neither of which were thought to impede accurate fish counts; and 3 = little hiding cover and good water clarity. Only pools with a visibility rank of two or three are used in data analysis. If all pools in a reach have visibilities < 2, then as many pools in the reach as possible will be electrofished using Smith-Root model 12-B backpack electrofishers following NMFS electrofishing guidelines for juvenile salmonid presence/absence. Electrofishing will be conducted by making a single pass upstream in each pool that meets the size and depth criteria for conducting snorkel surveys. No block nets will be used for this sampling. Electrofishing data will be used to determine the presence and percent of pools occupied by juvenile *O. mykiss* and spring chinook.

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*Subtask 2.2.4* -- Test probabilistic sampling based approaches.

*Methods 2.2.4.* -- Sampling methods, domains and site selection

Based on current environmental monitoring programs (U.S. EPA 1998, 2000, Oregon Plan 1997, WA CMS 2001), and scientific review of proposed salmonid and habitat monitoring programs (ISRP reviews of numerous proposals across several provinces) the sampling framework adopted for testing in this project is the US Environmental Protection Agency's EMAP. While the program has been implemented regionally for water quality monitoring (U.S. EPA 2000) and salmonid population and habitat monitoring (Oregon Plan), there are a number of aspects of the sampling frame that should be tested prior to program implementation in each new ecoregion. Therefore, while an EMAP sampling framework will underlie the development of this monitoring program, concomitant testing of the sampling program design will occur.

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- 3 panels with different repeat intervals
- 17 of the sites will be sampled every year
- 16 sites will be allocated to a 4 year rotating panel (sites visited once every 4 years on a staggered basis)
- 17 sites will be new sites each year

With this sampling strategy, 50 sites will be drawn the first year and 33 new sites will be drawn in subsequent years because 17 of the originally drawn sites will be repeated each year. The rotating panel approach is in a sense a bet-hedging strategy, distributing samples between random and fixed sites due to an incomplete understanding of the spatio-temporal variance structure of the monitoring program's indicators. An explicit goal of this program will be to collect all indicator data in the variance partitioning framework outlined in *Task 2.2* to test the efficiency of the rotating panel approach, and the fraction of sites distributed to fixed and random categories.

Similarly, there is nothing "magical" about 50 samples per subbasin since precision increases gradually with increase in sample size. For the most part, we want a good estimate of the variance of our target population. Small sample sizes give poor estimates of the variance, and with small samples, random draws can be quite a bit off from the actual population's characteristics (mean, variance, median). Fifty is a rule of thumb to get a reasonably good picture. Another reasonably good rule of thumb is that doubling precision requires a four-fold increase in sample size. So if you get a particular precision at 50 samples, you'd need 200 samples to double precision. However, once again, 50 samples is an initial guess that can be refined with data collection on indicator variance structure.

*Objective 3.*

Implement the salmonid and habitat status and trend monitoring program developed in *Objective 2* through the cooperative agreement developed in *Objective 1.*

*Task 3.1.*

Implement a pilot status and trend monitoring program for salmonids and their habitat in the Wenatchee River basin.

*Methods 3.1.1.* – Habitat and Juvenile Salmonid Monitoring

Sample 50 randomly selected 1-km reaches in each of the four major watershed of the upper Wenatchee River basin. The sampling universe will be 5$^{th}$ order and smaller stream from the 1:100k EPA River Reach file. Sample size was determined based on the minimum number of sites necessary to quantify current conditions (status) and detect trends in conditions over time. Sampling will be based on methods for habitat and juvenile monitoring developed in *Tasks* associated with *Objective 2* (protocols and methods modified as needed from: Jones and Moore, 1999; Rodgers, 2000; Thom et al., 2000). Habitat sampling will determine current habitat conditions in each of the watersheds and allow for assessing how habitat conditions change in the future. Current habitat conditions will also be compared to habitat survey undertaken by US Forest Service. Juvenile salmonid sampling will determine the current distribution and abundance of salmonids in each of the 4 watersheds and trends in distribution and abundance of salmonids over time. In addition, trends among the watersheds can be compared over time as functions of differing degrees of resource management and human impact.

*Methods 3.1.2.* – Steelhead and Spring Chinook Adult Monitoring

Sample 50 randomly drawn 1-km reaches in each of the four watersheds. The sampling universe will be the range of steelhead and Chinook spawning in each of the four watersheds. Sample size is based on the minimum number of sites necessary to quantify current conditions (status) and detect trends in conditions over time. Sampling will be based on protocols and methods developed in *Tasks* associated with *Objective 2* for spawning surveys. Each site will be visited once every 10 – 14 days across the entire spawning season to develop cumulative redd counts. Spawner sampling will determine the current abundance (status, ±40%) and distribution of adult steelhead and chinook in each of the four watersheds and allow the assessment of abundance and distribution change over time.

*Task 3.2.*

Implement a pilot status and trend monitoring program for salmonids and their habitat in the Grande Ronde River basin.

*Methods 3.2.1.* – Habitat and Juvenile Salmonid Monitoring

Sample 50 randomly selected 1-km reaches in each of the four major watershed of the upper Grande Ronde River basin. The sampling universe will be $5^{th}$ order and smaller stream from the 1:100k EPA River Reach file. Sample size was determined based on the minimum number of sites necessary to quantify current conditions (status) and detect trends in conditions over time. Sampling will be based on methods for habitat and juvenile monitoring developed in *Tasks* associated with *Objective 2* (protocols and methods modified as needed from: Jones and Moore, 1999; Rodgers, 2000; Thom et al., 2000). Habitat sampling will determine current habitat conditions in each of the watersheds and allow for assessing how habitat conditions change in the future. Juvenile salmonid sampling will determine the current distribution and abundance of salmonids in each of the 4 watersheds and trends in distribution and abundance of salmonids over time. In addition, trends among the watersheds can be compared over time as functions of differing degrees of resource management and human impact.

*Methods 3.2.2.* – Steelhead and Spring Chinook Adult Monitoring

Sample 50 randomly drawn 1-km reaches in each of the four watersheds. The sampling universe will be the range of steelhead and chinook spawning in each of the four watersheds. Sample size is based on the minimum number of sites necessary to quantify current conditions (status) and detect trends in conditions over time. Sampling will be based on protocols and methods developed in *Tasks* associated with *Objective 2* for spawning surveys. Each site will be visited once every 10 – 14 days across the entire spawning season to develop cumulative redd counts. Spawner sampling will determine the current abundance (status, ±40%) and distribution of adult steelhead and chinook in each of the four watersheds and allow the assessment of abundance and distribution change over time.

## g. Facilities and equipment

Staff to support and supervise this project will be based at the NMFS's Northwest Fisheries Science Center in Seattle, WA. The NWFSC supports research efforts across the region with a large staff of laboratory and field fisheries biologists, as well as a research staff specializing in mathematical and statistical analysis of population and environmental data. In addition, the NWFSC has strong IT and IM support for the development and maintenance of information and data management systems.

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|---|---|
| to the Oregon Plan for Salmon and Watersheds, Governor's Natural Resources Office, Salem, Oregon. | |
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| Thom, B. A., P. S. Kavanagh, and K. K. Jones. 2001. Reference Site Selection and Survey Results, 2000. Monitoring Program Report Number OPSW-ODFW-2001-6, Oregon Department of Fish and Wildlife, Portland, Oregon. | N |
| U.S. EPA. 1998. Environmental Monitoring and Assessment Program (EMAP): Research Plan 1997. EPA/620/R-98/002. U.S. Environmental Protection Agency, Washington, D.C. | N |
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| WA CMS. 2001. Washington State Comprehensive Monitoring Strategy. http://www.wa.gov/iac/SalmonMonitoring.html | N |
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## Section 10 of 10. Key personnel


Christopher E. Jordan, Ph.D. 0.1 FTE
Mathematical Biology and Systems Monitoring, Program Manager
NMFS Northwest Fisheries Science Center
2725 Montlake Blvd. E.
Seattle, WA 98112


**Education:**

| | | | |
|---|---|---|---|
| University of Washington | Ph.D. | 1994 | Zoology |
| University of Chicago | B.A. | 1985 | Biology |

**Positions Held:**

| | | |
|---|---|---|
| Program Manager | NOAA/NMFS/NWFSC, Seattle, | 2002 - present |
| Operations Research Analyst | NOAA/NMFS/NWFSC, Seattle | 1999 - 2002 |

| | | |
|---|---|---|
| Research Assistant Professor | Washington State Univ., Pullman | 1999 - present |
| Assistant Professor | University of Colorado, Boulder | 1995 - 1999 |
| Research Associate | University of Chicago, Chicago | 1994 - 1995 |
| Research/Teaching Assistant | University of Washington, Seattle | 1987 - 1994 |

**Mathematical and Biological Publications:**

Jordan, C.E. 1992. A model of rapid starting intermediate Reynolds number swimming: Undulatory locomotion in the chaetognath Sagitta elegans. *J. exp. Biol*. **163**, 119-137.

Daniel, T.L., C.E. Jordan, and D. Grunbaum. 1992. Hydromechanics of animal locomotion. In: *Mechanics and Energetics of Animal Locomotion, Advances in Comparative and Environmental Physiology, Vol. 11.*, pp. 17-49. ed. R.McN. Alexander. Springer Verlag, Berlin.

Jordan, C.E. 1996. Coupling internal and external mechanics to predict swimming behavior: a general approach? *Amer. Zool.*, **36**(6):710-722.

Steinberg, E.K. and C.E. Jordan. 1997. Using genetics to learn about the ecology of threatened species: the allure and the illusion of measuring genetic structure in natural populations. In: Conservation Biology. eds, P. Fiedler and P. Kareiva. Chapman Hall, New York.

Katz, S.L. and C.E. Jordan. 1997. A case for building integrated models of aquatic locomotion that couple internal and external forces. In: Proceedings of the 10th International Symposium on Unmanned Untethered Submersible Technology: Bioengineering. AUSI, Durham, NH.

Jordan, C.E. 1998. Scale effects in the kinematics and dynamics of swimming leeches. (**76**(10):1869-1877, Can. J. Zool.)

McClure, M. M., Sanderson, B. L., Holmes, E. E. & Jordan, C. E., (2001). A large-scale, multi-species risk assessment: Anadromous salmon in the Columbia River Basin. Ecol. Apps. In Review

Philip R., C.E. Jordan, M.C. Liermann, and A.E. Steel. (2002) Monitoring design: important considerations for developing monitoring of aquatic restoration. In review

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KEY PERSONNEL FOR MAJOR SUBCONTRACTING RESPONSIBILITIES

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## ROBERT M. BUGERT

Governor's Salmon Recovery Office
1133 North Western Avenue
Wenatchee, WA 98801-1229

**Education:**

Graduate, Washington Agriculture and Forestry Education Foundation, Class XI.
M. S. Fisheries Resources, University of Idaho, Moscow. 1985.
B. S. Wildlife Biology, Washington State University, Pullman. 1977.

**Experience:**

*1998 to present*
*Eastern Washington Coordinator, Governor's Salmon Recovery Office.*

Policy and technical advisor to the Governor=s Office on salmon recovery and the Endangered Species Act (ESA). Assist local governments and stakeholders in development of regional salmon recovery plans. Facilitate Habitat Conservation Plan (HCP) negotiations between the federal government and irrigation districts, conservation districts, and county governments. Serve as liaison between executive and legislative branches of state government. Serve as chair of the Snake River and Upper Columbia Regional Technical Teams.

*1995 to 1998*

*Technical Facilitator, Mid-Columbia Public Utility Districts, Wenatchee, Washington.*

Facilitated technical negotiations among agency, tribal, and utility scientists in a multi-species HCP for five major hydroelectric dams on the Columbia River. Served as technical advisor on salmon issues to watershed councils and irrigation districts for HCP development. Established means to provide financial and technical incentives to private landowners to protect salmonid habitats. Developed consensus strategy documents for both habitat and hatchery management in the Columbia River upstream of the Yakima River confluence.

*1991 to 1995*

*Fishery Biologist, Washington Department of Fish and Wildlife, Wenatchee, Washington.*

Project leader of four large-scale hatchery research programs in Columbia River. Project leader of six hatchery support programs. Agency technical representative on salmon issues to ESA Recovery Team, Northwest Power Planning Council, and several interagency groups. Served as a technical liaison to National Marine Fisheries Service on Sections 7 and 10 of ESA.

*1985 to 1991*

*Fishery Biologist, Washington Department of Fisheries, Dayton, Washington.*

Research project leader for artificial and natural production of salmon on lower Snake River. Secured funding, developed experimental design, and lead research team. Primary focus was to study (1) effects of hatcheries on wild salmon population dynamics and genetic resources, and (2) barging salmonids through Snake River dams. Assisted landowners with upland and riverine restoration projects. Served as agency technical representative to ESA Biological Review Team.

**BRUCE A. MCINTOSH, Ph.D.**

ODFW Oregon Plan Monitoring Coordinator

Oregon Department of Fish and Wildlife, 28655 Highway 34, Corvallis, OR 97333

## Education and Experience

B.S., Wildlife Biology-University of Montana, 1982
M.S., Forest Ecology-Oregon State University, 1992
Ph.D., Forest Ecology-Oregon State University, 1995

2000 – present — Oregon Plan Monitoring Coordinator, Oregon Department of Fish and Wildlife and Assistant Professor (Courtesy), Departments of Fisheries and Wildlife and Forest Science, Oregon State University

| | |
|---|---|
| 1999 – 2000 | Assistant Professor, Dept of Forest Science, Oregon State University |
| 1996 – 1999 | Research Associate, Dept of Forest Science, OSU |
| 1992 – 1996 | Faculty Research Assistant, Dept of Forest Science, OSU |

Principal areas of research:

Assessment of the structure, function, and dynamics of aquatic ecosystems

Evaluation of historical changes in aquatic ecosystem structure and function and the influence of anthropogenic and natural disturbance on these changes

Multi-scale methods to assess aquatic condition and community structure of watersheds

Freshwater ecology of fish assemblages of the Pacific Northwest

The use of remote sensing techniques for across scale assessments and watershed monitoring

**Selected Publications:**

Torgersen, C.E., R.N. Faux, B.A. McIntosh, N.J. Poage, and D.J. Norton. In press. Airborne Thermal Remote Sensing for Water Temperature Assessment in Rivers and Streams. Remote Sensing of Environment.

Faux, R.N., and B.A. McIntosh. 2000. Stream temperature assessment using forward-looking infrared (FLIR). Conservation Biology in Practice, 1(10): 38-39.

McIntosh, B.A., J.R. Sedell, R.F. Thurow, S.E. Clarke, and G.L. Chandler. 2000. Historical changes in stream habitats in the Columbia River basin. Ecological Applications, 10(5): 1478-1496.

Torgersen, C.E., D.M. Price, B.A. McIntosh, and H.W. Li. 1999. Multiscale thermal refugia and stream habitat associations of hinook salmon in northeastern Oregon. Ecological Applications, 9(1): 301-319.

McIntosh, B.A., J.R. Sedell, J.E. Smith, R.C. Wissmar, S.E. Clarke, G.H. Reeves, and L.A. Brown. 1994. Historical changes in fish habitat for select river basins of eastern Oregon and Washington. Northwest Science, 68(Special Issue): 36-53.

James B. Scott, Jr.
Chief Fish Scientist
Science Division, Fish Program
Washington Department of Fish and Wildlife

EDUCATION

M.S., Fisheries, University of Washington 1982
B.S., Fisheries, University of Washington 1980

PROJECT RESPONSIBILITIES

Mr. Scott will serve as the principal contact and coordinator for WDFW contributions to the project.

EXPERIENCE

Mr. Scott joined the Washington Department of Fish and Wildlife (WDFW) in 1999 to lead the newly created Science Division. His primary area of expertise is simulation and analytical models of biological systems. This expertise has been applied in a variety of applications in domestic and international forums. He served as co-chair of the Pacific Salmon Commission Chinook Technical Committee from 1991 through 2001, and was a technical advisor for the renegotiation off the Pacific Salmon Treaty in 1999. Since joining WDFW, his work has focused on developing procedures to evaluate the risks and benefits of artificial production and providing the technical basis for recovery goals for listed species. As manager of the Science Division, comprised of over 130 FTEs, he has the responsibility of assuring that the production and management of fish resources by WDFW is grounded on a sound scientific basis.

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Example Publications:

Scott, J.B., C.R. Steward, and Q.J. Stober. 1983. The effects of urban nonpoint source pollution upon stream fish population dynamics. TAFS 115: 555-567.

Scott, J.B., Jr. 1990. Design of fishery sampling programs. In. P. Knudsen (editor), “14th Northeast Pacific Pink and Chum Workshop”, pages 10-13. Washington State Department of Fisheries.

Puget Sound Salmon Stock Review Group. 1992. Assessment of the status of five stocks of Puget Sound chinook and coho as required under the PFMC definition of overfishing. Pacific Fishery Management Council. 113pp. (co-author)

Ken MacDonald
Fisheries Program Manager, Okanogan-Wenatchee National Forest
US Forest Service
215 Melody Ln
Wenatchee, WA 98801

Education and Experience

| | |
|---|---|
| B.A., Fisheries | Oregon State University, 1977 |
| B.A., Forestry | Oregon State University, 1982 |

20+ years of habitat management and monitoring of fish populations for the USFS.

## Congratulations!